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(19)

(54) IMPROVEMENTS IN OR RELATING TO SPRING BRAKE ACTUATORS

(71) We, AUTOMOTIVE PRODUCTS LIMITED, a British Company, of Tachbrook Road, Leamington Spa, Warwickshire, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned with brake actuators of the kind known as spring brake actuators, and relates to a spring assembly therefore. A spring brake actuator comprises an actuator rod associated with a movable wall; and a casing which defines an enclosure bounded by the movable wall, the actuator rod being urged in the brake applying direction by the action upon the movable wall, of a stack of Belleville washers, the actuator rod being arranged to be held against the action of the Belleville washers by the action upon the movable wall of fluid pressure within the enclosure: a spring brake actuator of this kind is referred to hereinafter as a spring brake actuator of the kind referred to.

The Belleville washers may be stacked in one of two arrangements. In the first arrangement, they are stacked chevron-wise, that is the convex surface of one washer of a pair of juxtaposed washers faces the concave surface of the other washer in a stack of washers. Such an arrangement of a stack of washers allows the stack to have a shorter length in comparison to the second arrangement where either the convexity, or the concavity of each of the washers of each juxtaposed pair of Belleville washers of the stack are opposed one to the other. In the second arrangement, frictional losses between juxtaposed washers are minimal upon deflection of the washer but, the length of the stack is in excess of the length of the stack in the first arrangement. However, in the first arrangement, frictional losses between juxtaposed washers during deflection are greater than those occurring during deflection of the washers in the second arrangement. It has been found that when a Belleville washer is deflected over-centre, a greater magnitude of work may be obtained from the washer in comparison to the work obtained when the washer is deflected somewhat less than over-centre. Accordingly, in a spring brake actuator, it is desirable to arrange the stack of washers chevron-wise as in the first arrangement.

It is an object of the present invention to reduce frictional losses between Belleville washers stacked chevron-wise in a spring brake actuator.

According to one aspect of the present invention, there is provided a spring assembly for a spring brake actuator of the kind referred to, which spring assembly comprises at least two Belleville washers stacked chevron-wise, the washers of the or each juxtaposed pair being separated by at least one layer of a solid lubricous material to reduce frictional forces generated during deformation of said washers by an axial force applied to said spring assembly.

The or each said layer may be a plastics material having a low coefficient of friction. The plastics material may be polyurethane, or, nylon, or, polytetrafluoroethylene. The or each said layer may be an elastomeric material.

The or each layer may be bonded to a surface of at least one washer of a respective pair of said washers. Such layer may be defined by a respective disc.

Each of said washers may be coated with a said material to define a said layer.

According to another aspect of the present invention, there is provided a spring brake actuator of the kind referred to,

wherein the Belleville washers are stacked chevron-wise, the washers of each juxtaposed pair being separated by at least one layer of a solid lubricous material to reduce frictional forces generated during deformation of said washers by an axial force applied to said washers.

The invention will now be described by way of example with reference to the drawing which is:—

A sectional elevation of a brake and a brake actuator embodying the present invention.

Referring to the drawings, a brake disc 10 is mounted for axial sliding movement on a shaft or wheel (not shown) to which the braking forces are to be applied, and a caliper 11 is fixedly mounted in such a manner that a part thereof extends across the periphery of the disc 10. The mounting of the caliper is not shown, arrangements for mounting of such calipers being well known. The part of the caliper 11 which extends across the periphery of the brake disc is shown at 12, a tubular portion 13 of the said caliper, which lies on one side of the brake disc 10 and has its axis parallel to the brake disc axis, being connected by the part 12 of the caliper to a radially inwardly extending limb 14 lying on the other side of the brake disc 10. The bore of the tubular portion 13 of the caliper 11 defines, at its end adjacent the brake disc 10, a first cylinder 15, the bore at the other end of the said tubular portion defining a second cylinder 16 of larger diameter than the first cylinder 15 and between the cylinders 15 and 16 there is provided a connecting bore 17 of slightly smaller diameter than the first cylinder 15.

A piston 18, hereinafter called the brake applying piston is slidable in the cylinder 15 and acts on a first brake pad 19 slidably located in the caliper in any suitable manner so as to be movable in a direction parallel to the axis of the brake disc, the said brake pad 19 acting on the side of the brake disc 10 adjacent the tubular portion 13 of the caliper. A second brake pad 21, fixed to the limb 14 of the caliper, acts on the other side of the brake disc 10.

A push rod 22, the length of which is adjustable as will be hereinafter described, extends through the connecting bore portion 17, one end of the push rod 22 engaging the brake applying piston 18 and the other end thereof being acted upon by spring means 23 defined by a stack of Belleville washers 223 taking their abutment on a stop, such as a ring 24, in turn supported by a clip ring 25 engaging in a groove in the wall of the cylinder 16, so that the spring means can exert a thrust acting through the brake applying piston 18 to the brake pad 19, the reaction of the said spring means being taken by the caliper 11.

The Belleville washers 223 in the stack of washers 23, are spaced one from another by a layer of a solid lubricous material, the layer being constituted by a disc 123. Each disc is formed of a plastics material having a low coefficient of friction. A material found to be suitable is nylon, but polyurethane or polytetrafluoroethylene may be used. Alternatively, any other suitable plastics material having a low coefficient of friction may be used. It can be seen from the drawing that the Belleville washers are arranged chevron-wise one with respect to the others. When the spring stack is deflected, due to axial movement of a first brake release piston 26 within the cylinder 16 upon supply of pressure fluid thereto, the washers are deformed one with respect to another. Such deformation generates forces acting on the discs 123, but such forces are not transmitted fully to juxtaposed washers because, it is believed, a large proportion of such forces are absorbed by plastic deformation of the disc between juxtaposed washers.

The first brake release piston 26, fixed to the push rod, is slidable in the second cylinder 16, and a second brake release piston 27, surroundir the push rod and slidable both in the said second cylinder 16 and on the push rod, is positioned between the first brake release piston 26 and the end of the second cylinder adjacent the first cylinder, the said second brake release piston 27 having a reduced portion 28 slidable in the connecting bore portion 17.

Sealing rings are provided between the brake applying piston 18 and the first cylinder 15, between both brake release pistons 26 and 27 and the second cylinder 16, and between the reduced portion 28 of the second brake release piston 27 and both the connecting bore portion 17 and the push rod 22.

Ports 29, 30 and 31, each one of which can be connected selectively to a source of fluid pressure or disconnected therefrom to allow pressure at the said port to be relieved, lead respectively into the first cylinder 15, into the second cylinder 16 between the second brake release piston and the end of that cylinder adjacent the connecting bore portion 17, and into the second cylinder 16 between the two brake release pistons 26 and 27.

The push rod 22 is formed in two parts, namely a stem 32 and a sleeve 33 surrounding the said stem, the stem and sleeve being formed with mating screw threads 34 of the multi-start type so formed as to provide some clearance between the threads allowing axial lost motion between the stem and sleeve. The first brake release piston 26 is carried by the sleeve 33.

The stem 32 of the push rod has fixed to it a head 35 having a frusto-conical surface 36 which mates with a complementary surface 37 at the inner end of a cavity 38 in the brake applying piston 18. The said stem 32 is urged towards the end of the said piston 18 engaging the brake pad 19 by a spring 39 engaging at one end with one race 41 of a ball thrust bearing 42 interposed between the said spring and the head 35, and at the other end with an abutment ring 43 located in the cavity 38 by a clip ring 44. The spring 39 thus tends to hold the frusto-conical surfaces 36 and 37 in engagement to serve as a clutch holding the piston 18 and stem 32 against relative rotation.

The brake applying piston 18 is held against rotation, for example by a peg 45 thereon engaging in a hole in a backing plate 46 carrying the brake pad 19. The sleeve 33, at its end remote from the head 35, has a non-tubular extension 47 of non-circular cross-section which extends into a correspondingly shaped hole in a detachable end plate 48 closing the outer end of the cylinder 16 in the tubular portion of the caliper. The end plate 48 is secured to the caliper by means such as bolts 49 which hold it against rotation, so that, when the end plate 48 is in position the sleeve 33 is also held against rotation.

It will be apparent that fluid pressure acting in the cylinder 15 will apply the brake by urging the brake applying piston 18 towards the limb 14 of the caliper, pressing the pad 19 against the brake disc 10 and thereby pressing the said brake disc against the pad 21. Similarly, in the absence of fluid pressure acting on both of the brake release pistons 26 and 27, the stack of Belleville washers 223 will act on the piston 18 through the push rod 22 to apply the brake. Whilst the Belleville washers are so acting, friction between the frusto-conical surfaces 36 and 37 holds the stem 32 against rotation, so that the push rod does not decrease in length.

If fluid pressure is applied to either one of the connections 30 or 31 it acts on the brake release piston 27 or 26 to support the load of the spring means 23 and remove such load from the brake applying piston 18, so that the spring means 23 exert no applying force on the brake pads. The brake can then be applied and released by respectively admitting fluid pressure to, and releasing fluid pressure from, the cylinder 15.

During application of the brake by fluid pressure in the cylinder 15, the piston 18 moves away from the brake release piston 26, which, with the sleeve 33 is held by fluid pressure in the cylinder 16, against movement. The spring 39 tends to urge the stem 32 of the push rod to follow the piston 18, the stem thus moving relative to the sleeve 33. A small degree of movement is taken up by the clearance between the screw threads, but if the piston movement exceeds the movement allowed by such clearance, the complementary surface 37 is pulled away from the frusto-conical surface 36 on the head 35, thus reducing the friction opposing rotation of the stem 32, and the latter rotates in the sleeve 33 to extend the push rod and take up excess movement due to pad wear.

When a set of brake pads have worn out, and new pads must be fitted, the brake applying piston 18 must be retracted. This is done by removing the end plate 48, thus releasing the sleeve 33 for rotation, and rotating the said sleeve to reduce the length of the thrust rod 22.

Inward movement of the push rod 22 by the stack of Belleville washers 223 is limited by abutment of the first brake release piston 26 on the second release piston 27, which in turn abuts against the inner end of the cylinder 16. Thus, provided that the push rod 22 is not at its minimum length, the brake can be released when it has been applied by the Belleville washers and no fluid pressure is available to act on the pistons 26 and 27 to release them, by rotating the sleeve 33 to reduce the length of the thrust rod.

It will be observed that the reduced portion 28 of the second brake release piston 27 is exposed to fluid pressure in the cylinder 15 so that fluid pressure acting on the brake applying piston 18 to apply the brakes will also exert a thrust on the brake-releasing piston 27 to oppose the thrust of the Belleville washers. Consequently, even when no pressure is acting in the cylinder 16 to oppose the thrust of the Belleville washers, the said thrust will be at least partially balanced by fluid pressure, and the thrust exerted on the brake applying piston 18 will be less than the sum of the fluid pressure thrust and the Belleville washer thrust, thus reducing the risk of applying an excessive load.

In an alternative arrangement, both radial surfaces of each Belleville washer 223 are coated with a layer of a plastics material having a low coefficient of friction. It is preferred to use polytetrafluoroethylene (PTFE) but any other suitable plastics material such as polyurethane or nylon may be used.

In a further arrangement, each disc 123 may be formed of an elastomeric material such as natural or synthetic rubber.

In the alternative arrangement, both radial surfaces of each Belleville washer may be coated with natural or synthetic rubber instead of a plastics material having a low coefficient of friction.

In yet a further arrangement, each disc 123 may be bonded to at least one of the

washers 223 of a juxtaposed pair of washers.

It will be understood that the present invention is applicable to spring brake actuators for drum brakes as well as for disc brakes.

WHAT WE CLAIM IS:—

1. A spring assembly for a spring brake actuator of the kind referred to, which spring assembly comprises at least two Belleville washers stacked chevron-wise, the washers of the or each juxtaposed pair being separated by at least one layer of a solid lubricous material to reduce frictional forces generated during deformation of said washers by an axial force applied to said spring assembly.

2. A spring assembly as claimed in Claim 1 wherein the or each said layer is a plastics material having a low coefficient of friction.

3. A spring assembly as claimed in Claim 2 wherein said plastics material is polyurethane.

4. A spring assembly as claimed in Claim 2 wherein said plastics material is nylon.

5. A spring assembly as claimed in Claim 2 wherein said plastics material is polytetrafluoroethylene.

6. A spring assembly as claimed in Claim 1 wherein the or each layer is an elastomeric material.

7. A spring assembly as claimed in any one of the preceding claims wherein the or each said layer is bonded to a surface of at least one washer of a respective pair of said washers.

8. A spring assembly as claimed in any one of the preceding claims wherein the or each said layer is defined by a respective disc.

9. A spring assembly as claimed in any one of Claims 2 to 6 wherein each of said washers is coated with a said material to define a said layer.

10. A spring assembly substantially as herein described with reference to, and as shown in, the accompanying drawing.

11. A spring brake actuator of the kind referred to, the actuator including a spring assembly as claimed in any one of the preceding claims.

12. A spring brake actuator of the kind referred to, wherein the Belleville washers are stacked chevron-wise, the washers of each juxtaposed pair being separated by at least one layer of a solid lubricous material to reduce frictional forces generated during deformation of said washers by an axial force applied to said washers.

13. A spring brake actuator of the kind referred to, the actuator being substantially as herein described with reference to, and as shown in, the accompanying drawing.

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1405832 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*